

On the Aphid–ant association and its relationship with various host plants in the Agroecosystems of Vadodara, Gujarat, India

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Abstract

Aphid-ant association and its relationship with various host plants is age old and in most of the cases remains unreported. The present research deals with the extent of damage caused by aphids, a major pest of economically important crops. It also focuses on the role of ants in spreading this pest from one crop to another in the agroecosystems of Vadodara. Hence the objectives of the present study were: to identify the aphid species infesting various agricultural crops with an aim to control them; and to identify ants and host plants associated with the aphid species. Three species of aphids, *Aphis crassivora*, *A. gossypii* and *A. nerii* were collected from the fields and later identified. Ants associated with aphids were *Camponotus compressus*, *Monomorium minimum*, *Pheidole* sp. and *Solenopsis* sp. The ant *Camponotus* sp. usually acts as one of the main cause of spread of aphids from one plant to another. Aphid–ant association was seen in 30 economically important crops maximally from the families Malvaceae, Fabaceae, Solanaceae and Brassicaceae. Ant–aphid association if disrupted can control the population of aphids in the agricultural fields. Therefore, the management of ants can be added as a key component in management of serious pests like aphids.

Keywords: *Aphid-ant association, agroecosystems.*

Introduction

Aphids (Homoptera: Aphidoidea) and ants (Hymenoptera: Formicidae) are the protagonists of one of the most studied model of mutualistic relationships in the animal kingdom (Detrain *et al.*, 2010). This aphid–ant association has strong interaction with various host plants. Aphids are one of the major pests of the economically important crops of Vadodara like cotton, castor, pigeon pea, cow pea, etc. Razaq *et al.* (2011) reported 10-90% yield loss in India to the economically important crops depending upon severity of damage and crop stage by aphids.

It is a well-known fact that an ant colony tends simultaneously several aphid species, thus there can be intra or interspecific competition between aphid groups for the services of ants. Aphids produce a carbohydrate and nitrogen rich excretion called as honeydew, which is collected by ant species; in return provide protection and hygiene to aphids. This in popular terms is known as mutual interaction.

In India, few cases on aphid–ant association have been reported, but none from Vadodara agricultural fields. Keeping this in mind, the present study was conducted

on aphid-ant association and its relationship with various host plants in and around agricultural fields of Vadodara. The main objectives of the work were to: 1) identify the aphid species infesting various agricultural crops with an aim to control them. 2) identify ants and host plants associated with aphid species.

Materials and Methods

Study was conducted from September 2008 to May 2011. Survey sites were chosen on the basis of accessibility and location within an eco-region. Vadodara District is located in the eastern part of the state of Gujarat in western India at 22°17'59"N, 73°15'18"E, 35 m above the sea level. Aphid infestation was studied in agricultural fields of Vadodara, located within 80 kms of Vadodara city. All fields were approximately 2-5 ha in size. The main crops cultivated are Cotton, Castor, Sugar cane, Pigeon pea, Chickpea, Ladies finger, Potato, Brinjal, Radish, Cauliflower, Wheat, Paddy and Maize.

Collection of female aphids was done by hand collection from aphid infested plants. For collection of ants pitfall and hand collection methods were used, collected specimens were preserved in 70% alcohol for laboratory identification. A stereomicroscope, Leica MPS 60 Ø28/8x/MPS was used for identification and photographic record. Photography was done using a Canon digital camera (Power Shot ISI-120, 12x optical zoom). Aphids were identified using Blackman and Elastop (2000) and later confirmed in the Entomology Division of the Anand Agricultural University Anand. Ants were identified using the keys provided by Bolton (1994). The identification of host plant species were done by Department of

Botany, The Maharaja Sayajirao University of Baroda.

Assessment of incidence and infestation rate of aphids

The assessment of infestation by insect pests on various crops was done as per the "1-4 Scale infestation" scale (Nagrare *et al.*, 2011).

- a) 1 Grade: Scattered appearance of few aphids on the plant.
- b) 2 Grade: Severe infestation of aphids on any one branch of the plant.
- c) 3 Grade: Severe infestation of aphids on more than one branch or half portion of the plant.
- d) 4 Grade: Severe infestation of aphids on the whole plant.

Results and discussion

The incidence of aphid population on various host plants was observed from September 2008 to May 2011. Infestation of aphids start appearing in the month of September. As the crop grows, population of the aphids on the crop also increases. Maximum population of aphids was observed in the months of November to January which gradually starts decreasing in the months of February and March. Aphid population disappears totally in the month of April to reappear again in September. This was the observation for all the three consecutive years in agricultural fields of Vadodara. Karim *et al.* (2001) also reported that the aphid population started growing from August, became highest in January and almost vanished in April.

Our results clearly show that aphids are polyphagous and cause severe damage to many host plants (Table 1). In Vadodara, 30 host plant species were recorded from 17

different families. Takaloozadeh (2010) from Iran also reported *Aphis gossypii* attacking more than 70 different host plants. Major hosts of the aphids in agriculture fields of Vadodara are *Gossypium arboreum*, *Vigna unguiculata*, *Solanum tuberosum* and *Solanum melongena*. Whereas ornamental plants such as; *Hibiscus mutabilis*, *Hibiscus rosa-sinensis*, *Nerium indicum*, *Chrysanthemum* sp. and certain weeds like *Calotropis procera* worked as alternative host of aphids. Plant species belonging to family Malvaceae (17%), Fabaceae (16%), Solanaceae (12%) and Asclepiadaceae (10%) were found as preferred host plants of aphids in Vadodara (Fig. 1).

Aphid-ant interaction is commonly seen on various host plants; about 30 host plants and 6 species of aphids namely *Aphis brassicae*, *A. crassivora*, *A. fabae*, *A. gossypii*, *A. nerii*, *Myzus persicae* were recorded from Vadodara agricultural sites (Table 2). Most abundant species considered as major pests in Vadodara include *Aphis gossypii*; *Aphis crassivora* and *Aphis nerii*. Ants commonly associated with aphids involve *Camponotus compressus*, *Pheidole* sp., *Monomorium* sp. and *Solenopsis* sp.

A. brassicae was mostly seen on the Brassicaceae family (cabbage and cauliflower) with *Pheidole* ants associated with them. *A. crassivora* was mainly found on the family Fabaceae, Malvaceae and Lamiaceae with ants *Camponotus compressus* and *Monomorium minimum* associated with them. Along with these ants; the family Lamiaceae also had association with ant *Lasius niger* which is rarely seen in other host plants. *A. fabae* mostly seen on the family Fabaceae, Solanaceae, Asteraceae, Amaranthaceae and Papaveraceae in association with ants *Camponotus*

compressus and *Monomorium* sp. But in Solanaceae and Papaveraceae, ants *Pheidole* sp. and *Solenopsis* sp. were also seen.

In Vadodara agricultural fields, *A. gossypii* is one of the major threats to Cotton. *A. gossypii* was mainly found on Malvaceae, Solanaceae and Asteraceae family having strong interaction with *Camponotus compressus*, *Monomorium* sp. and *Pheidole* sp. Patel *et al.* (2011) reported that 1326 insect species damage Cotton (*Gossypium* spp.) in approx. 100 countries, of which 16 species are of major concern causing an annual loss of 50-60% of the total production in Northern Gujarat. The ratio of ants and aphids per plant on cotton crops was found to be 1:30. Whereas *A. nerii* was also associated with the *Camponotus compressus* on *Nerium* and *Calotropis* plants; ant *Monomorium* sp. was found on the family Asteraceae and Amaranthaceae and the *Solenopsis* sp. was on the family Rutaceae and Poaceae. *Myzus persicae* mainly seen on the family Malvaceae, Brassicaceae, Amaranthaceae and Solanaceae and the associated ants are *Camponotus compressus* and *Monomorium* sp. In spinach and brinjal, aphid association was seen with *Solenopsis* sp. and *Pheidole* sp.

The species of ants such as *Camponotus compressus*, *Pheidole* sp. and *Monomorium* sp. was seen on aphids on different crops but *Camponotus compressus* being the major one. Thus, the aphid association is commonly seen with *Camponotus compressus* and *Monomorium* sp. The host plants were varying but the aphid-ant association remains the same. Maximum aphid - ant association was found on cotton crop along with beans and pigeon pea. But less association of aphid-ant interaction were seen on Brassicaceae and Utriacae.

A mutual interaction was observed between aphids and ants. Aphids produce honeydew excretion which is a food for ants and ants gives protection to aphids. In Ankara Plant Protection Central Research Institute of Turkey, Ozdemir *et al.* (2008) reported 16 different species of ants associated with 19 aphid species. The most encountered ant species associated with many aphid species were *Camponotus aethiops*, *Camponotus piceus*, *Formica glauca*, *Lasius paralienus* and *Crematogaster orididula*. In Vadodara district, *Pheidole* sp. and *Camponotus compressus* were observed tending aphid colonies on many plants. Vinson and

Scarborough (1989) also found out the presence of few red imported fire ants, *Solenopsis invicta* workers on aphid bearing cotton plants reduced aphid predators effectiveness in laboratory. *Camponotus compressus* was generally found on almost all the host plants, generally acting as a carrier could most possibly be one of the reasons of aphid dispersion from one plant to other host plant in Vadodara. Hence the present study persuades us to study more about these associated relationships and for understanding of the patterns and processes associated with aphid-ant relationships.

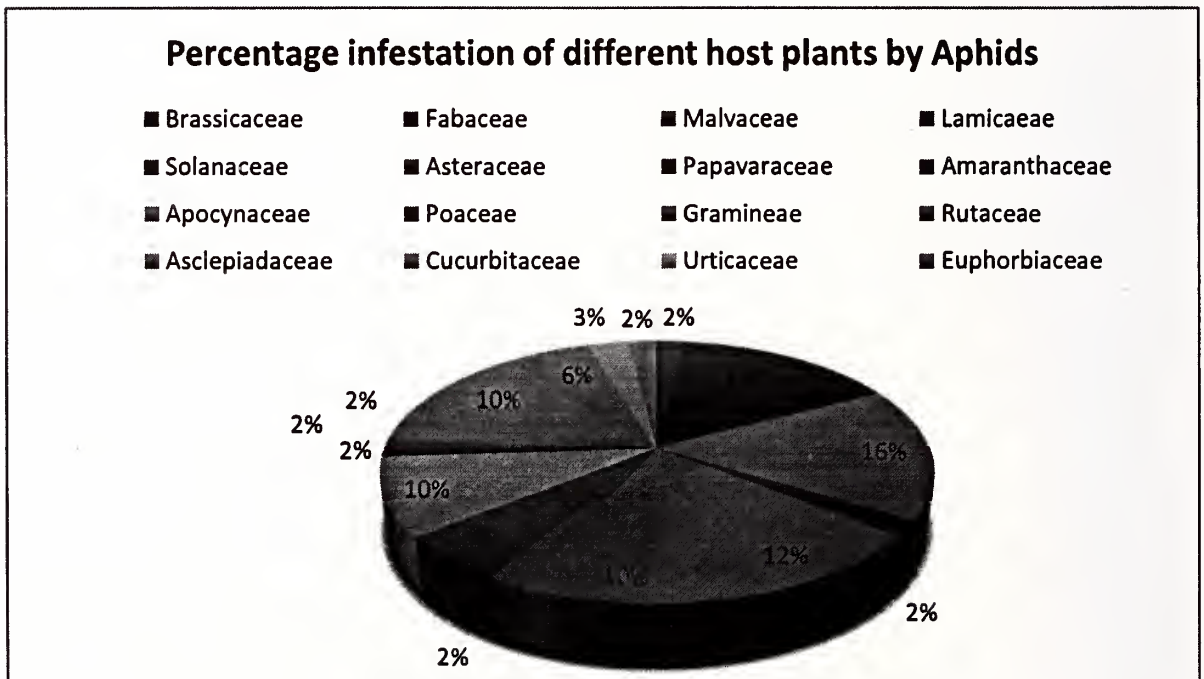


Fig. 1: Percentage infestation of different host plants by aphids.

Table 1: Host plants of Aphids with its infestation level in agrosystem of Vadodara.

Host category	Botanical Name	Common Name	Family	Infestation Scale
Field crops	<i>Gossypium hirsutum</i> (L.)	Cotton	Malvaceae	4 Grade
	<i>Ricinus communis</i> (L.)	Castor	Euphorbiaceae	1 Grade
	<i>Cajanus cajan</i> (L. Millsp.)	Pigeon pea	Fabaceae	4 Grade
	<i>Vigna unguiculata</i> (L.)	Cow pea	Fabaceae	4 Grade
	<i>Zea mays</i> (L.)	Maize	Poaceae	2 Grade
	<i>Triticum aestivum</i> (L.)	Wheat	Gramineae	2 Grade
Vegetables	<i>Solanum melongea</i> (L.)	Brinjal	Solanaceae	3 Grade
	<i>Solanum tuberosum</i> (L.)	Potato	Solanaceae	3 Grade
	<i>Lycopersicon esculentum</i> (L.)	Tomato	Solanaceae	4 Grade
	<i>Abelmoschus esculentus</i> (L.)	Lady's finger	Malvaceae	4 Grade
	<i>Brassica oleracea</i> (Linn)	Cabbage	Brassicaceae	2 Grade
	<i>Beta vulgaris</i> (L.)	Beet	Papaveraceae	0 Grade
	<i>Cucumis sativus</i> (L.)	Cucumber	Cucurbitaceae	2 Grade
	<i>Spinacia oleracea</i> (L.)	Spinach	Amarathaceae	2 Grade
Ornamental crops/ Fruit trees/trees and shrubs	<i>Nerium indicum</i> (Mill.)	Oleander	Apocynaceae	2 Grade
	<i>Tagetes erecta</i> (L.)	Marigold	Asteraceae	1 Grade
	<i>Hibiscus mutabilis</i> (L.)	Cotton rose-mallow	Malvaceae	3 Grade
	<i>Hibiscus rosa-sinensis</i> (L.)	China rose	Malvaceae	4 Grade
	<i>Ocimum sanctum</i> (L.)	Tulsi	Lamiaceae	1 Grade
	<i>Helianthus annuus</i> (L.)	Tulsi	Asteraceae	1 Grade
	<i>Papaver somniferum</i> (L.)	Opium poppy	Amaranthaceae	0 Grade
	<i>Rosa indica</i> (L.)	Rose	Rosaceae	1 Grade
	<i>Atriplex rosea</i> (L.)	Red orach	Asteraceae	0 Grade
	<i>Matricaria recutita</i> (L.)	Chamomile	Asteraceae	0 Grade
	<i>Nerium oleander</i> (L.)	Oleander	Apocynaceae	4 Grade
	<i>Vinca rosea</i> (L.)	Periwinkle	Apocynaceae	1 Grade
	<i>Citrus limonium</i> (L.)	Lemon	Rutaceae	2 Grade
	<i>Chrysanthemum</i> sp. (L.)	Chrysanthus	Asteraceae	3 Grade
	<i>Urtica dioica</i> (L.)	Stinging nettle	Urticaceae	0 Grade
Weeds	<i>Datura metel</i> (L.)	Angel's trumpet	Solanaceae	0 Grade
	<i>Chenopodium album</i> (L.)	Pigweed	Asteraceae	1 Grade
	<i>Cirsium arvense</i> (L. Scop)	Canada thistle	Asteraceae	1 Grade
	<i>Calotropis procera</i> (W.T.Aiton)	Apple of sodom	Asclepiadaceae	4 Grade
	<i>Gomphocarpus</i> sp. (E.mey.)	Cotton bushes, Balloon bushes	Asclepiadaceae	2 Grade
<i>Asclepias</i> (E.mey.)	Butterfly weed	Asclepiadaceae	2 Grade	

Table 2. Aphid- Ant association and their host plants in the agricultural fields of Vadodara

APHIDS	FAMILY	HOST PLANTS	ANTS
<i>Aphis brassicae</i> (Linnaeus ,1758)	<i>Brassicaceae</i>	<i>Brassica oleracea</i> (Linn) (Cabbage)	<i>Pheidole</i> sp.
<i>Aphis crassivora</i> (Koch, 1854)	<i>Fabaceae</i>	Leguminous crops <i>Cajanus cajan</i> (L. Millsp.) (Pigeon pea)	<i>Camponotus compressus</i>
	<i>Fabaceae</i>	<i>Vigna unguiculata</i> (L.) (Cow pea/ Beans)	<i>Camponotus compressus</i> <i>Monomorium minimum</i>
	<i>Malvaceae</i>	<i>Hibiscus rosasinesis</i> (L.) (China rose)	<i>Camponotus compressus</i> <i>Monomorium minimum</i>
	<i>Lamiaceae</i>	<i>Ocimum sanctum</i> (L.) (Tulsi)	<i>Monomorium minimum</i> <i>Lasius niger</i> <i>Camponotus compressus</i>
<i>Aphis fabae</i> (Scopoli,1763)	<i>Fabaceae</i>	<i>Vigna unguiculata</i> (L.) (Cow pea/Beans)	<i>Camponotus compressus</i> <i>Monomorium</i> sp.
	<i>Solanaceae</i>	<i>Solanum tuberosum</i> (L.) (Potato)	<i>Camponotus compressus</i> <i>Pheidole</i> sp.
	<i>Asteraceae</i>	<i>Helianthus annuus</i> (L.) (Sun flower)	<i>Monomorium minimum</i>
	<i>Solanaceae</i>	<i>Solanum lycopersicum</i> (L.) (Tomato)	<i>Monomorium</i> sp.
	<i>Papaveraceae</i>	<i>Beta vulgaris</i> (L.) (Beet)	<i>Monomorium</i> sp.
	<i>Amaranthaceae</i>	<i>Papaver somniferum</i> (L.) (Opium Poppy)	<i>Solenopsis</i> sp. <i>Monomorium</i> sp.
	<i>Asteraceae</i>	<i>Chenopodium album</i> (L.) (Lamb's quarters/Pigweed)	<i>Monomorium minimum</i>
	<i>Asteraceae</i>	<i>Atriplex rosea</i> (L.) (Red orach) <i>Matricaria recutita</i> (L.) (Chamomile) <i>Cirsium arvense</i> (L.Scop) (Canada thistle)	
<i>Aphis nerii</i> (Boyer de Fonscolombe , 1841)	<i>Apocynaceae</i>	<i>Nerium oleander</i> (L.) (Oleander)	<i>Camponotus compressus</i>
	<i>Apocynaceae</i>	<i>Vinca</i> sp. (L.) (Periwinkle)	<i>Monomorium minimum</i>
	<i>Poaceae</i>	<i>Zea mays</i> (L.) (Maize)	<i>Solenopsis</i> sp.
	<i>Gramineae</i>	<i>Triticum aestivum</i> (L.) (Wheat)	<i>Solenopsis</i> sp. <i>Monomorium</i> sp.
	<i>Rutaceae</i>	<i>Citrus limonium</i> (L.) Burm.f. (Lemon) <i>Calotrophis</i> sp.(R.Br.) (Milkweed)	<i>Camponotus compressus</i> <i>Solenopsis</i> sp.
	<i>Asclepiadaceae</i>	<i>Gomphocarpus</i> sp. (E.mey.) (Cotton bushes, Balloon bushes)	<i>Camponotus compressus</i>
	<i>Asclepiadaceae</i>	<i>Asclepias</i> (E.mey.) (Butterfly weed)	<i>Camponotus compressus</i>

Table 2: continued

<i>Aphis gossypii</i> (Glover, 1877)	<i>Malvaceae</i>	<i>Gossypium</i> sp. (L.) (Cotton)	<i>Camponotus compressus</i>
	<i>Solanaceae</i>	<i>Solanum melongena</i> (L.) (Brinjal)	<i>Camponotus compressus</i> <i>Pheidole</i> sp.
	<i>Cucurbitaceae</i>	<i>Cucumis sativus</i> (L.) (Cucumber)	<i>Camponotus compressus</i>
	<i>Malvaceae</i>	<i>Hibiscus rosa sinensis</i> (L.) (China rose)	<i>Monomorium minimum</i> <i>Camponotus compressus</i>
	<i>Asteraceae</i>	<i>Chrysanthemum</i> sp. (L.) (Chrysanthus)	<i>Monomorium minimum</i> <i>Camponotus compressus</i>
	<i>Urticaceae</i>	<i>Urtica dioica</i> (L.) (Stinging nettle)	<i>Solenopsis</i> sp.
<i>Myzuspercicae</i> (Sulzer, 1758)	<i>Malvaceae</i>	<i>Gossypium</i> sp. (L.) (Cotton)	<i>Camponotus compressus</i> <i>Solenopsis</i> sp.
	<i>Amaranthaceae</i>	<i>Spinacia oleracea</i> (L.) (Spinach)	<i>Monomorium</i> sp. <i>Camponotus</i> sp. <i>Pheidole</i> sp.
	<i>Brassicaceae</i>	<i>Brassica oleracea</i> (Linn) (Cabbage)	<i>Monomorium</i> sp.
	<i>Brassicaceae</i>	<i>Raphanus sativus</i> (L.) (Radish)	<i>Camponotus compressus</i>
	<i>Solanaceae</i>	<i>Solanum melongena</i> (L.)	<i>Pheidole</i> sp.

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